Radiation pressure forces and blowout sizes for particles in debris disks

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Debris disks are a type of circumstellar disk that contain dust generated by collisions and disruptions of protoplanets and/or planetesimals. To interpret scattered light observations of debris disks, it is useful to compare modeled grain size distributions to radiation pressure blowout sizes. The ratio of radiation pressure to gravitational forces (β) acting on a dust grain depends on grain composition, size, and structure. Typically, β is calculated using the assumption of compact, spherical particles or accounting for porosity via the Maxwell-Garnett mixing rule (e.g., [1]). Calculations of radiation pressure balance for porous, irregular dust grains have been carried out for a handful of cases [2–4] using the discrete dipole approximation (DDA) method [5]. However, due to computational considerations, these focused on submicron particles that only require a small number of dipoles ($N \leq 2048$), but may be below the blowout size of some systems.

Here we present comparisons between Mie, Maxwell-Garnett, and DDA calculations of β for micron-sized grains using different stellar luminosities and grain compositions. The grain shapes and DDA implementation used to generate scattering and absorption efficiencies are similar to [6]. Stellar properties were chosen to correspond to stars known to host debris disks.

References

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